~~Lubricating Device~~

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Patent Application

of

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for

LUBRICATING DEVICE

Field of the Invention

The present invention relates to a lubricating device for gear trains, especially for wind power stations, with at least two gear stages ~~which are~~ located next to one another, and ~~which are~~ dynamically connected to one another, and a lubricant circuit ~~to which~~having at least one filter unit ~~is connected~~.

Background of the Invention

Lubrication devices for gear trains in wind power stations are known and readily available on the market~~, in which in~~. In the manner of closed circulating lubrication, the lubricant, especially in the form of lubricating oil, is removed by ~~means of~~ gear oil pumps from the gear sump of the gear housing with the gear stages, supplied to filtering by ~~means of~~ the filter unit, ~~and then, filtered in this way, is~~ for filtering, and discharged again to the interior of the gear housing ~~in order~~ to ~~thus~~ remove fouling, including in the form of metal shavings, from the lubricant. In spite of these measures, premature damage to the gears, which often occurs after six months, takes place in practical applications, both within the planet stage and ~~also~~ on the spur wheel stage~~, which~~ generally ~~form~~ forming the two gear stages

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for the rotor of a wind power station. In particular, the planet stage often fails due to defective planet bearings, as do the gear oil pumps of wind power stations due to metal shavings which occur with increased frequency in the lubricant circuit~~, the~~. The reason for ~~this being~~ such failures is that within the spur wheel stage, due to the formation of resting zones with large areas for the lubricant (oil~~)~~), it becomes possible for heavy metal particles to settle ~~there.~~in those resting zones. Often lubricant or oil exchange takes place only in the area of the spur wheel stage so that lubricant exchange takes place only conditionally, and contaminated or dirty lubricant can remain on the sides of the planet stage and can cause damage there.

Summary of the Invention

On the basis of this prior art, theAn object of the present invention is to further improve the known provide improved lubrication devices while retaining their advantages, such that they are reliable and economical in use, and that they ensure long-lasting gear train operation; this contributes, thereby contributing to increasing the time between expensive maintenance intervals.

This object is basically achieved by a lubrication device with the features of claim 1 in its entirety.

In that, as specified in the characterizing part of claim 1where, on one gear stage, the lubricant which is circulating in the lubricant circuit is drawn off, cleaned by the filter unit and then can be delivered to the respective other gear stage, stationary. Stationary resting or stagnation zones for the lubricant within the gear housing with the gear stages are avoided and it is ensured that in . In definable time intervals, all the lubricant circulating in the gear stages is delivered to the filter unit to be cleaned and filtered by it. For an average person skilled in the art in the area of lubrication devices, especially in the area of wind power stations, it comes as a surprise that, with the measure of permanent circulation while avoiding stationary resting zones in the lubricant or gear oil bath he obtains an, improved possibility for cleaning the lubricant flow by way of the filter unit is obtained. In particular, the heavy metal particles which otherwise settle can be continuously supplied to the circulation process; this. This ability leads to relief of the gear oil pumps and ultimately also of the gear stages, from which serious contaminants are removed. The pumps and whichgear stages can then perform their gear functionfunctions for a long time, to which the . The improved lubricant delivery at the respective gear stage also contributes to the extended performance.

In one preferred embodiment of the lubrication device as claimed in theof the present invention, provision is made such that in order to implement splash lubrication, the gear stages each individually and at least partially pass through a type of immersion bath with a lubricant reserve

~~which~~. The lubricant reserve has a subdivision such that each gear stage is assigned its own bath area. Preferably, the subdivision and the lubricant amount in the immersion bath are chosen such that overflowing lubricant from one gear stage with lubricant supply travels to the bath area ~~with~~ of the following gear stage ~~and~~with lubricant removal. This configuration provides ~~on the one hand for~~ optimum lubrication of the gear stages within the immersion bath of the lubricant ~~and it is~~, while still ~~ensured~~ensuring that within the immersion bath lubricant displacement and the respective continuous drawing off take place ~~with the result that removal~~. Removal of fouling from the lubricant or gear oil bath is then achieved continuously.

In another, especially preferred embodiment of the lubrication device ~~as claimed in the~~of the present invention, lubricant removal ~~consists~~includes of a suction device, and the lubricant supply ~~consists of~~includes an injection device~~, in~~. In the gear housing for the respective gear stage, the indicated devices are mounted diagonally opposite one another, extending through the upper and lower area of the housing. Due to this diagonal configuration, optimum lubricant distribution within the gear stages takes place ~~and the~~. The transit time for the lubricant between the gear stages from the injection side to the suction side is likewise optimized.

Preferably, the gear stage comprises a planet gear and a spur gear ~~and by means of~~. By the planet gear, it is possible to bring the rotor of the wind power station with its low rpm to higher rpm as required, ~~in order~~ to drive a generator for generating current or the like by ~~means of~~ the spur gear, in ~~an obvious~~ the known manner. For long-lasting and good lubricant operation, it has proven favorable to provide injection of a cleaned lubricant for the planet gear and to implement suction for contaminated lubricant on the spur gear stage.

The filter unit ~~which is~~ used preferably in the lubrication device in the direction of lubricant delivery ~~first of all~~ has a fine filter which is safeguarded with a bypass, followed by a coarse filter connected downstream in series. Cleaning results ~~have been~~ are especially good when the filter

fineness of the coarse filter is chosen to be approximately 5 to 10 times coarser than the filter fineness of the fine filter. Such a preferably suitable filter unit is described in DE 101 05 612 A1 of ~~the applicant~~Hydac Filtertechnik GmbH.

The lubrication device ~~as claimed in the~~ of the present invention need not be limited to gear stages in wind power stations~~, but~~. It can also be used for other gear stages and gear configurations, with and without planet gears.

~~The lubrication device as claimed in the~~ Other objects, advantages and salient features of the present invention will ~~be~~become apparent from the following detailed ~~below using one~~description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment ~~as shown in the drawings. The single figure shows the lubrication device as claimed in~~of the present invention ~~in the manner of a block diagram schematically and not to scale~~.

Brief Description of the Drawings

Referring to the drawings which form a part of this disclosure:

FIG. 1 is a schematic, block diagram, not to scale, of a lubrication device according to an embodiment of the present invention.

Detailed Description of the Invention

The lubrication device is used for a gear train ~~which is designated as a whole as~~ 10. The ~~pertinent~~ gear trains 10 ~~which are~~ shown in ~~the figure are~~ FIG. 1 is used in so-called wind power stations, in which a rotor (not shown), ~~which can be~~ driven by the force of the wind, delivers its output power to an input shaft 12 ~~and after~~. After passing through the gear train 10 the respective output power is delivered to an output shaft 14 ~~to~~ which, for example, can be connected to a generator (not shown) ~~can be connected~~ for generating electrical current. Since the rotor ~~in general~~

generally has very low rpm and the generator ~~for its~~ operation requires correspondingly higher input rpm, the gear train ~~calls for~~provides a step-up ratio from low to high rpm by a factor i of for example 1 : 80. The pertinent gear train assemblies for wind power stations are conventional ~~so that this no longer needs be detailed here~~, and need not be described in further detail.

~~Furthermore the pertinent~~ Such gear trains generally have two gear stages 16, 18, ~~and the respective~~with each gear stage ~~in turn can consist of~~ having several stage parts. In particular, ~~for~~ the first gear stage 16 ~~a so-called~~includes planet gear ~~is used~~ and ~~for~~ the second gear stage 18 includes a spur gear ~~is used, the pertinent~~, with those stages also being referred to as the planet stage ~~or~~ and the spur stage~~. Furthermore, the~~, respectively. The lubrication device ~~as claimed in the~~of the present invention, in the manner of a closed circle or loop, has a lubricant circuit 20. To propel the lubricant, a conventional motor pump unit 22 is used ~~which~~, and is subsequently safeguarded in the lubricant delivery or downstream direction by ~~way of~~ a check valve 24 of conventional design. A filter unit 26 is connected subsequently or downstream between the motor pump unit 22 and the two gear stages 16, 18.

As ~~furthermore is to be seen~~illustrated in the block diagram, on the second gear stage 18, the lubricant ~~which is~~ circulating in the lubricant circuit 20 is removed and then is supplied ~~by way of~~via the motor pump unit 22 to the filter unit 26 before the lubricant ~~which has been~~ cleaned in this way is then supplied to the ~~respective other~~ first gear stage 16. The ~~pertinent~~ lubricant circulation can be carried out independently of whether the rotor and accordingly the gear train 10 are in operation or not. In this manner, by ~~way of~~ a control which is not detailed, the lubricant can be cleaned even if the system itself is shut down, for example because, with respect to the prevailing wind, operation of the system would not be profitable.

To implement splash lubrication for gear stages 16, 18 ~~a type of~~ an immersion bath 28 is provided ~~which has~~having a definable lubricant reserve and into which the gear stages 16, 18 with

their gear wheels are at least partially immersed. A subdivision 30 is placed in the immersion bath 28, with each gear stage 16, 18 thus being assigned its own bath area 32, 34 in the process. In particular, the ~~indicated~~ subdivision 30 and the lubricant amount in the immersion bath 28 are chosen such that the overflowing lubricant 36 (see arrow representation) travels from ~~one~~first gear stage 16 with lubricant supply 38 to the second bath area 34 with the following gear stage 18 with lubricant removal or outlet 40 of the immersion bath 28.

In the selected embodiment, the lubricant removal 40 is formed ~~from~~with a suction device ~~and~~, while the lubricant supply 38 is formed ~~from~~ with an injection device~~, the pertinent~~. The suction and injection ~~action being~~ actions are adjustable by ~~way of~~ the working capacity of the motor pump unit 22. In particular, the indicated injection device is configured such that, for the purposes of a spraying-on process, parts of the first gear stage 16 are covered or fogged with the lubricant over a large area.

~~As is furthermore to be seen in the figure~~ As also illustrated in FIG. 1, in the gear housing 10 for the respective gear ~~stage~~ stages 16, 18, the ~~indicated~~ devices 38, 40 are mounted diagonally opposite one another~~, the~~. The lubricant supply 38 ~~extending~~extends through the upper part of the housing 10~~ and the~~. The lubricant removal 40, in the form of a suction device ~~penetrating~~, penetrates the housing area ~~formed~~ from the housing bottom. With respect to the diagonal configuration, it basically is also possible in one embodiment, which is not detailed, to supply the injection amount to the top of the spur wheel stage and to implement suction on the bottom of the planet stage. ~~But since~~ Since the planet stage in terms of its support is highly susceptible to fouling, it has proven advantageous to implement the ~~previous~~ diagonal ~~routing.~~arrangement. As already described, diagonal fluid guidance is promoted and improved in that the overflowing lubricant 36 is relayed from one bath area 32 into the other bath area 34 and then is available to a filtration process by ~~way of~~ the filter unit 26. Sedimentation or settling,

especially of heavy fouling components such as metal shavings or the like, in the bath area 32 is thus effectively controlled.

The filter unit 26 can be provided with a filter element~~; but it~~. It has proven advantageous to ~~first of all~~ provide a fine filter 44 ~~which is~~ safeguarded with a bypass 42 (spring-loaded check valve) in the lubricant delivery direction, followed by a coarse filter 46 ~~which is~~ connected downstream in series. In normal operation ~~provision is therefore made such that~~, the fine filter 44 performs removal of fouling in the lubricant circuit 20~~, and should~~. If the ~~pertinent~~ fine filter fail 44 fails, especially should it be clogged with dirt, ~~it would be possible for~~ the bypass valve 42 ~~to open~~opens and ~~for it~~ to then supply the fluid flow to the coarse filter 46~~, coarser~~. Coarser dirt is then ~~being~~ retained by ~~way of~~ the coarse filter 46 and ~~in no case can it~~cannot penetrate into the gear train 10 with its gear stages 16, 18 to cause damage. It has been found to be especially favorable for this application if the coarse filter is designed to be 10 times more coarse than the filter stage of the fine filter 44. Thus, the fine filter 44 can have a filter fineness of 5 µm and the coarser protective filter can have a filter fineness of 50 µm particle size. The pertinent, series-connected filter stages are prior art and it has proven especially effective to use filter units 26 according to ~~the teaching of~~ DE 101 05 612 A1 ~~of the applicant for this area of application~~(corresponding to U.S. Patent No. 7,279,091).

By a combination of suction from the oil sump on the spur wheel area and injection of lubricant into the planet stage after cleaning by ~~way of~~ the filter unit 26, lubricant supply for the gear train parts of wind power stations is achieved which ensures reliable and long-lasting, trouble-free operation even under harsh ambient conditions and with hard use.

The lubricant device ~~as claimed in~~of ~~the~~the present invention can be used by itself as a modular unit~~; but it~~. It can also be installed as an additional system to standard circulation lubrication or to immersion bath lubrication. Furthermore, the possibility also exists of integrating

an additional intake filter or intake screen (not shown) in the intake line to the motor pump unit 22 ~~in order in this way~~ to protect the hydraulic pump against damage caused by dirt. ~~Furthermore, analysis~~Analysis of the contents of an intake screen yields conclusions regarding wear processes in the gear train. The subdivision of the bath areas within the gear housing can also be formed by ribs or stiffeners of the gear housing. The planet stage 16 shown in ~~the figure~~FIG. 1 has so-called planet wheels which revolve around the sun wheel shown lowermost in the figure~~, and~~. As viewed in the ~~direction of looking at the~~ figure, the internal geared wheel is shown uppermost~~; the pertinent~~. The structure of the planet gearing is conventional so that it will not be described in further detail~~ed here~~.

As shown in ~~the figure~~FIG. 1, a gear stage or planet stage 16 forms the planet gearing or the so-called planet part of the gear train~~, conversely~~. Conversely, two gear stage or spur wheel stages 18 form the actual spur gear which is also called the spur part of the gear train. The diagonal lubrication concept ~~as claimed in the~~ of the present invention for the lubrication device can also be used for gear trains with a different number of gear stages. The check valve 24 inserted downstream ~~in front of~~from the pump 22 is optional, and not absolutely necessary. In particular the pertinent check valve 24 would be suited for pressure limitation~~, and the~~. The oil flow from the check valve could then be routed to the intake side of the pump (not shown).

While one embodiment has been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

LUBRICATING DEVICE

Abstract of the Disclosure

A lubricating device for gear trains (10), especially for wind power stations, includes at least two gear stages (16,18) that are disposed next to each other and are effectively interconnected, and a lubricant circuit (20) into which at least one filter unit (26) is mounted. To prevent stagnant resting zones for the lubricant from being created within the gear train housing including the gear stages, while ensuring that the entire lubricant that circulates in the gear stages is fed to the filter unit to be drawn off and filtered within predefined periods of time, the lubricant circulating inside the lubricant circuit (20) is discharged at one gear stage (18), is drawn off through the filter unit, and can then be fed to the other gear stage (16).